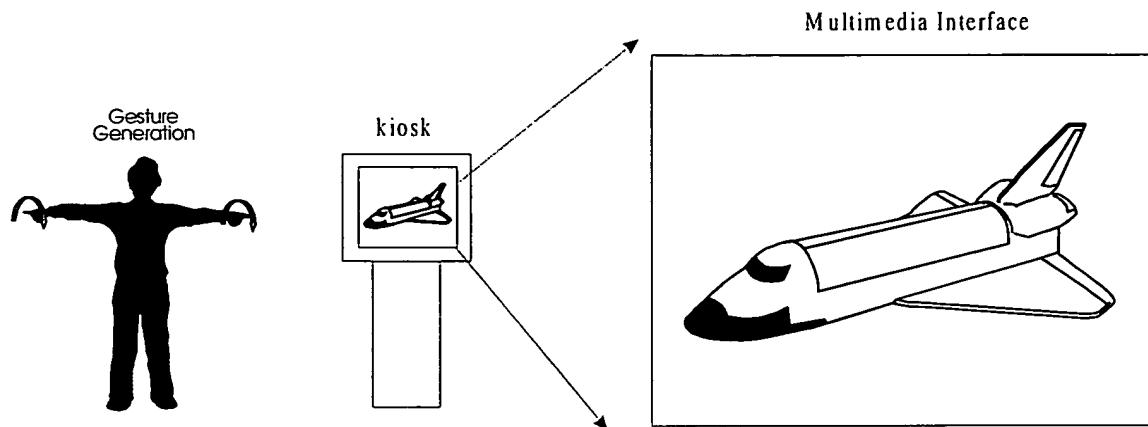
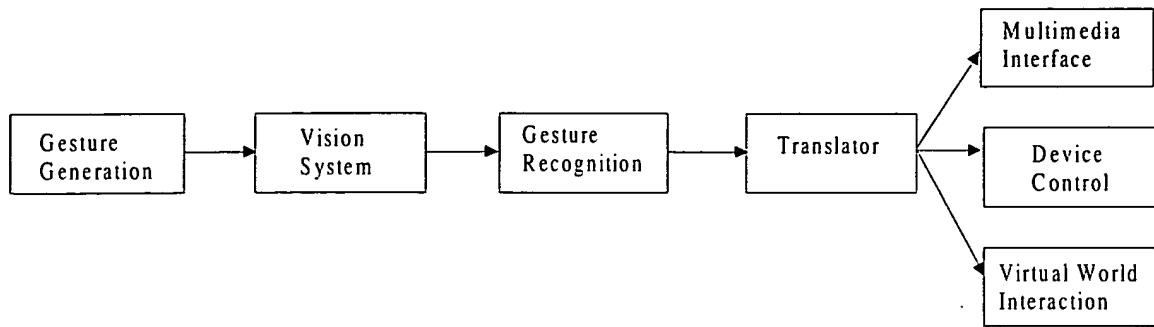


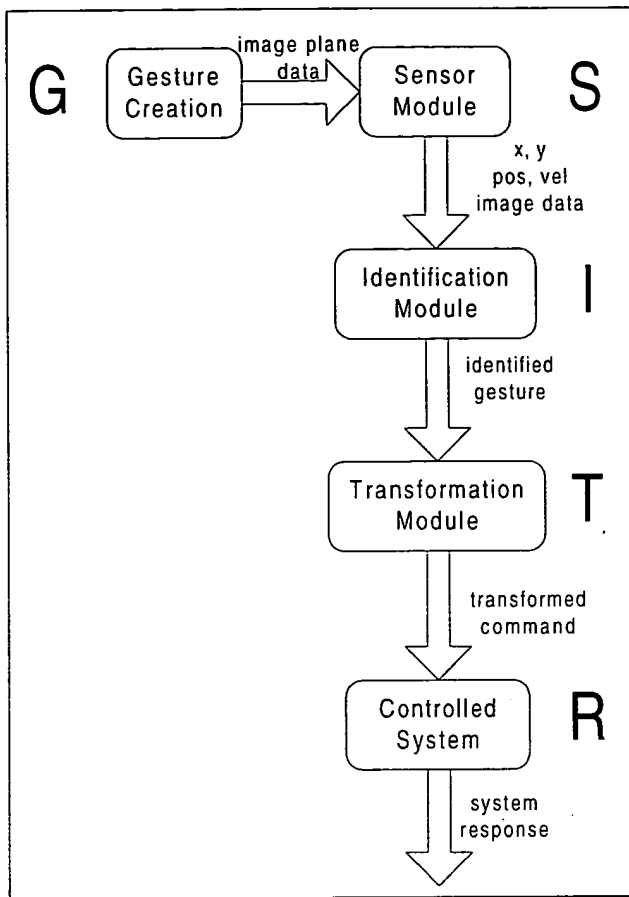
**Figure 1: Overview of Potential Behavior Recognition System Use.**



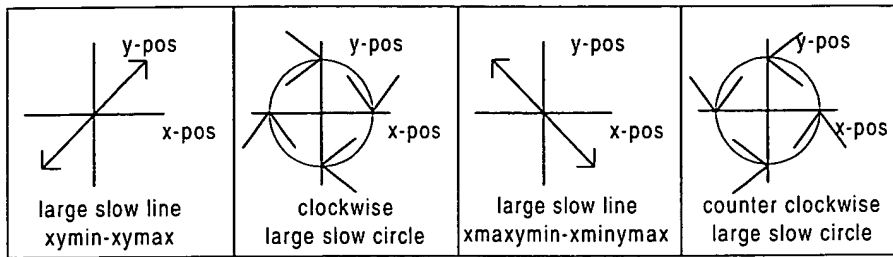
**Figure 2: Gesture Recognition System.**



**Figure 3: Gesture Recognition System Flow Chart.**

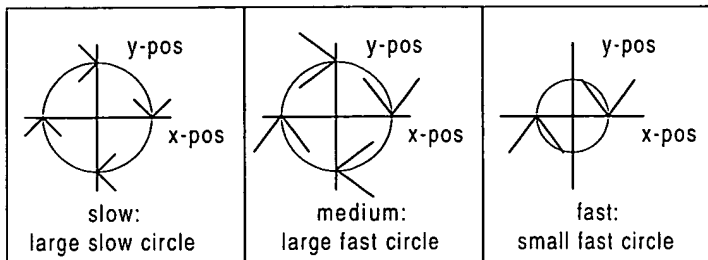


**Figure 4: Signal Flow Diagram of the Gesture Recognition System.**



**Figure 5: Example gestures, showed in two dimensions.**

Accepted for publication in the Journal of Experimental Psychology: Applied, 2014, 20(1), 1-12



**Figure 6: Three Example Gestures.**

Accepted for publication

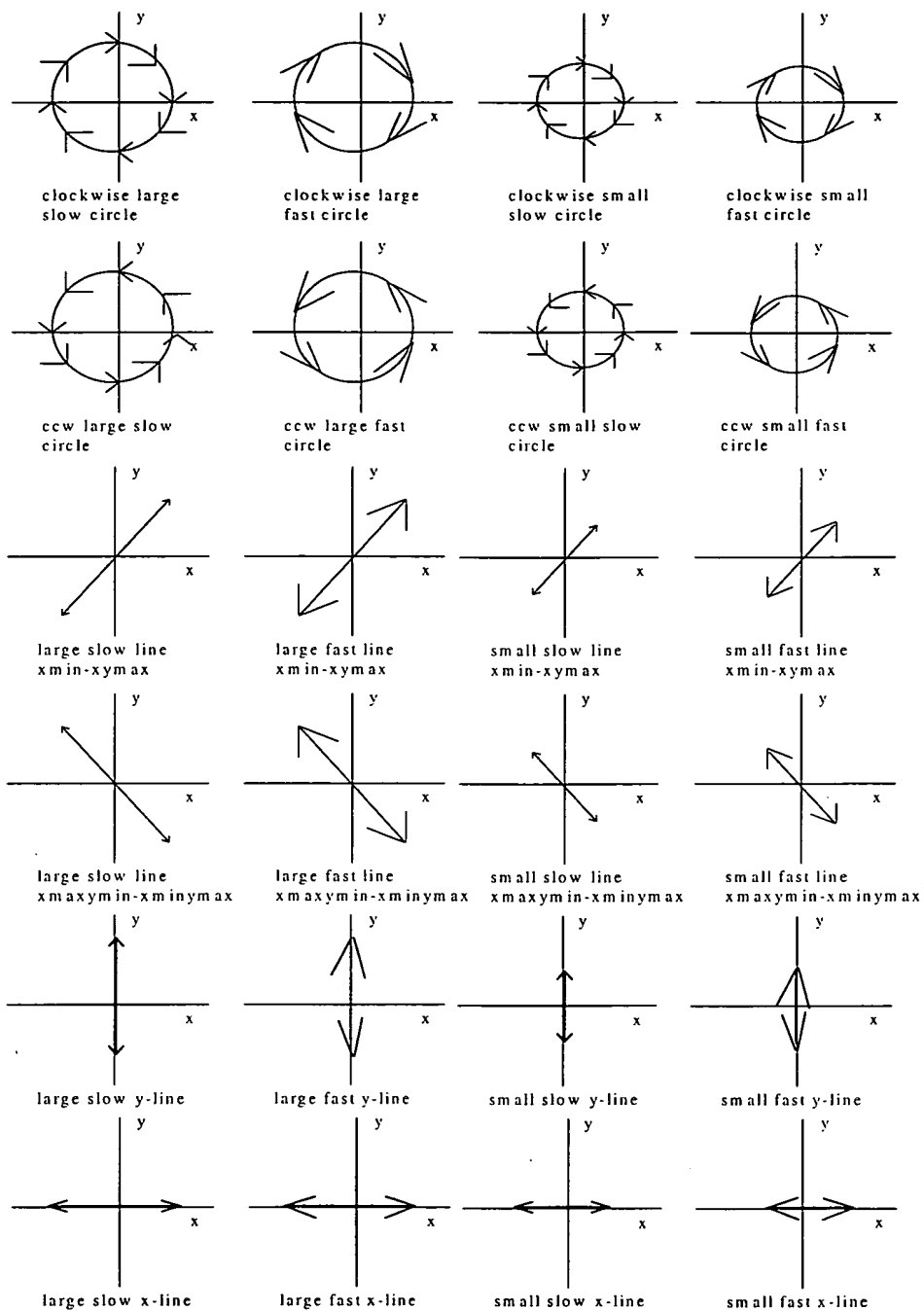
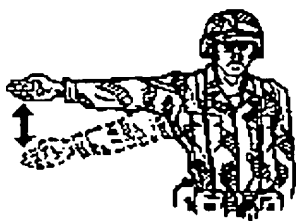


Figure 7: An Example 24 Gesture Lexicon.



#### DAY

Extend the arm horizontally sideward, palm to the front; wave the arm slightly downward several times, keeping the arm straight. Do not move arm above horizontal.

#### NIGHT

Hold a light at shoulder level; blink it several times toward the vehicle.

Figure 2-12. SLOW DOWN.

Figure 8: Slow Down Gesture.





#### DAY

Simulate cranking of engine by moving the arm, with the fist, in a circular motion at waist level.



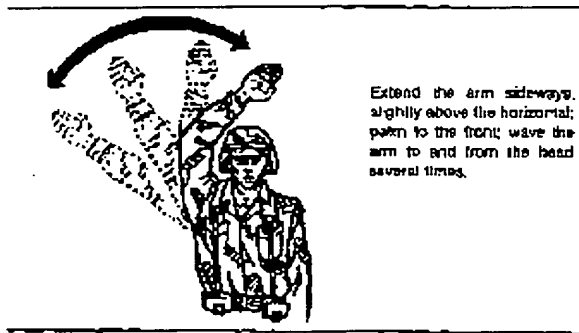
#### NIGHT

Move a light to describe a horizontal figure 8 in a vertical plane in front of body.

Figure 2-8. START ENGINE, or PREPARE TO MOVE

Figure 9: Prepare to Move Gesture.

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Extend the arm sideways, slightly above the horizontal; palm to the front; wave the arm to and from the head several times.

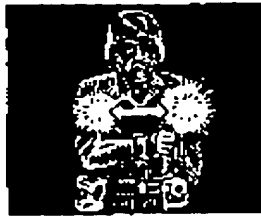
Figure 2-1. ATTENTION.

Figure 10: Attention Gesture.



#### DAY

Raise the hand upward to the full extent of the arm, palm to the front. Hold that position until the signal is understood.



#### NIGHT

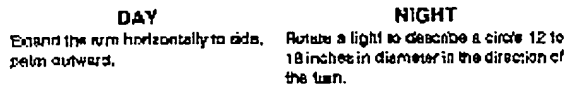
Move a light horizontally back and forth several times across the path of approaching traffic to stop vehicles. Use the same signal to stop engines.

**NOTE:** For alternate signal to stop vehicles, see Figure 2-17.

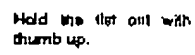
Figure 2-7 HALT or STOP.

Figure 11: Stop Gesture.

Approved for Release by NSA on 09-08-2013 pursuant to E.O. 13526



**Figure 12: Right or Left Turn Gestures.**



**Figure 2-22. MESSAGE ACKNOWLEDGED.**

**Figure 13: "Okay" Gesture.**

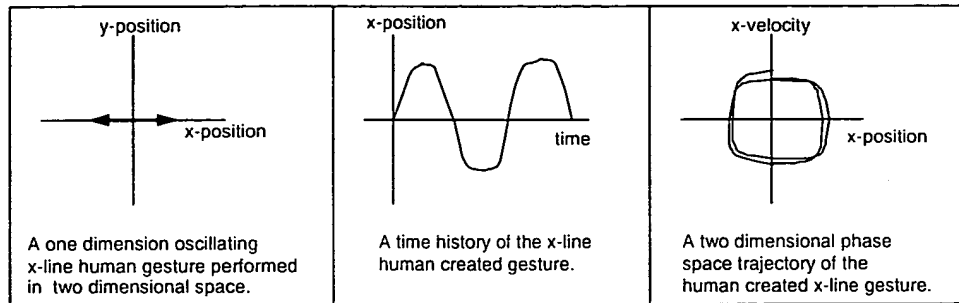
Raise the fist to head level.



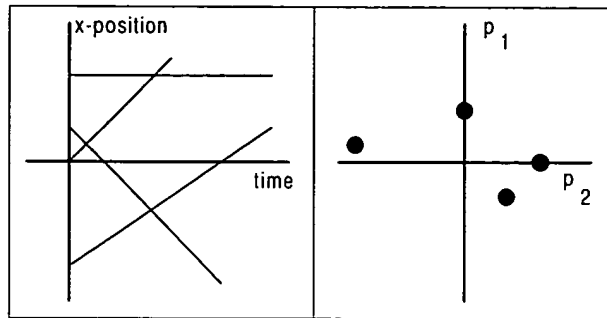
Figure 2-63. FREEZE

Figure 14: Freeze Gesture.

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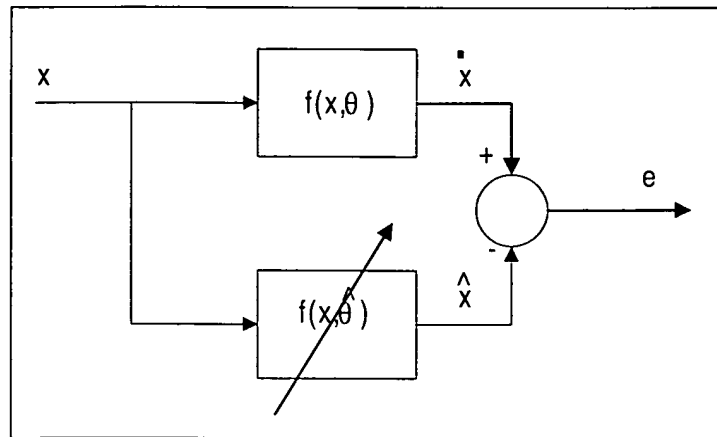
**Figure 15: Plots of a Human Created One Dimensional X-Line Oscillating Motion.**



**Figure 16: Possible Lines Associated with  $x(t,p)=p_0+p_1t$  and Their Equivalent Representation in the  $p$  Parameter Space.**

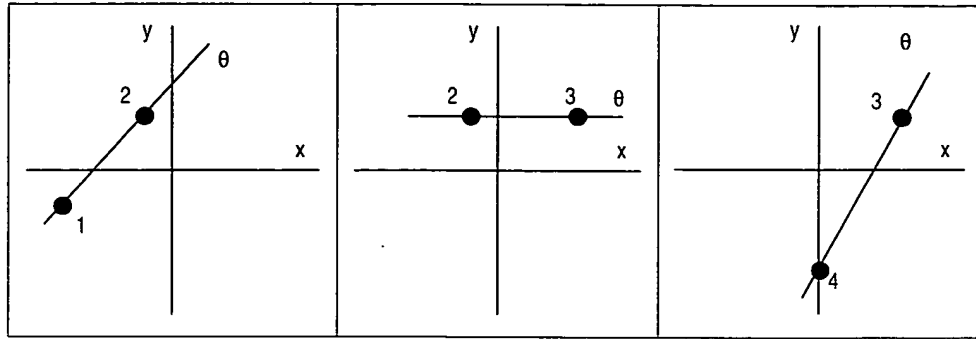
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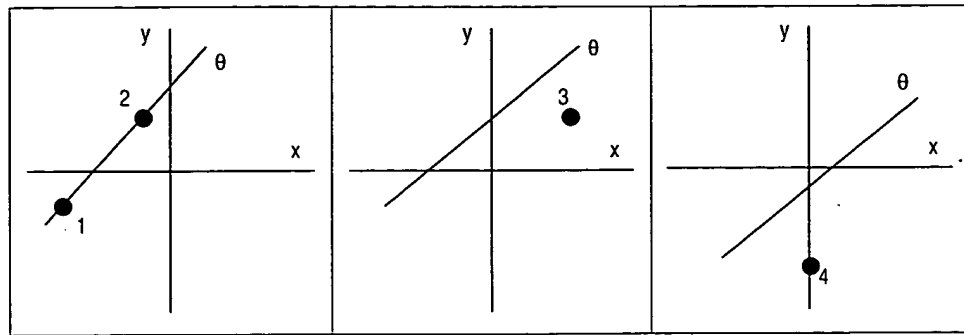
**Figure 17: Parameter Fitting: We Require a Rule for  $q$  to Bring the Error to Zero.**

Figure 17: Parameter Fitting: We Require a Rule for  $q$  to Bring the Error to Zero.



**Figure 18: Plots of Different  $(x_i, y_i)$  Data Points that Result in a Different Best Fitting  $q$  Line.**

Figure 18: Plots of Different  $(x_i, y_i)$  Data Points that Result in a Different Best Fitting  $q$  Line.



**Figure 19: The Recursive Linear Least Squares Method for Updating  $q$  with Each Additional  $(x_i, y_i)$  Data Point.**

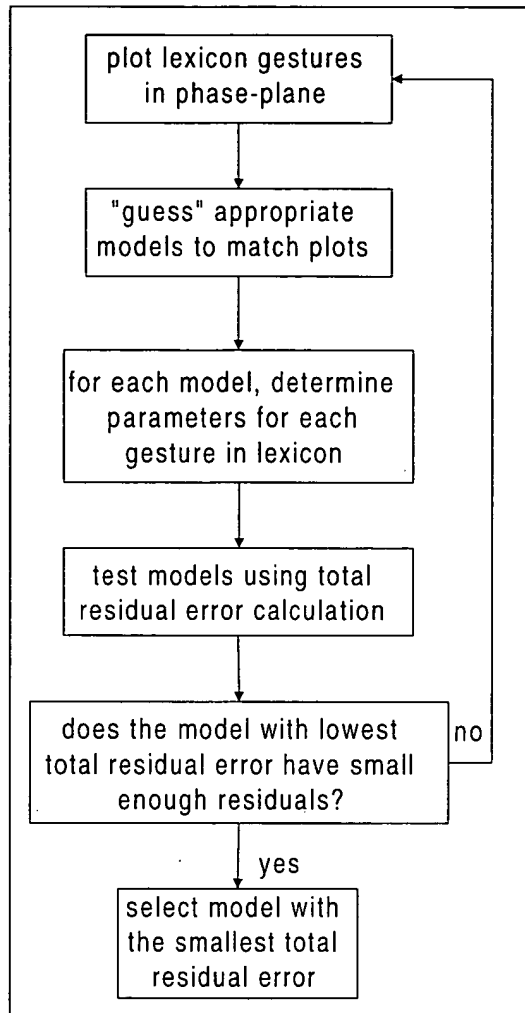
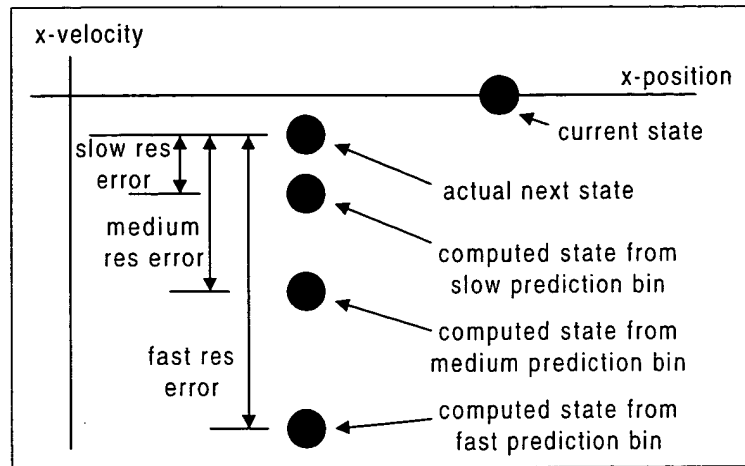
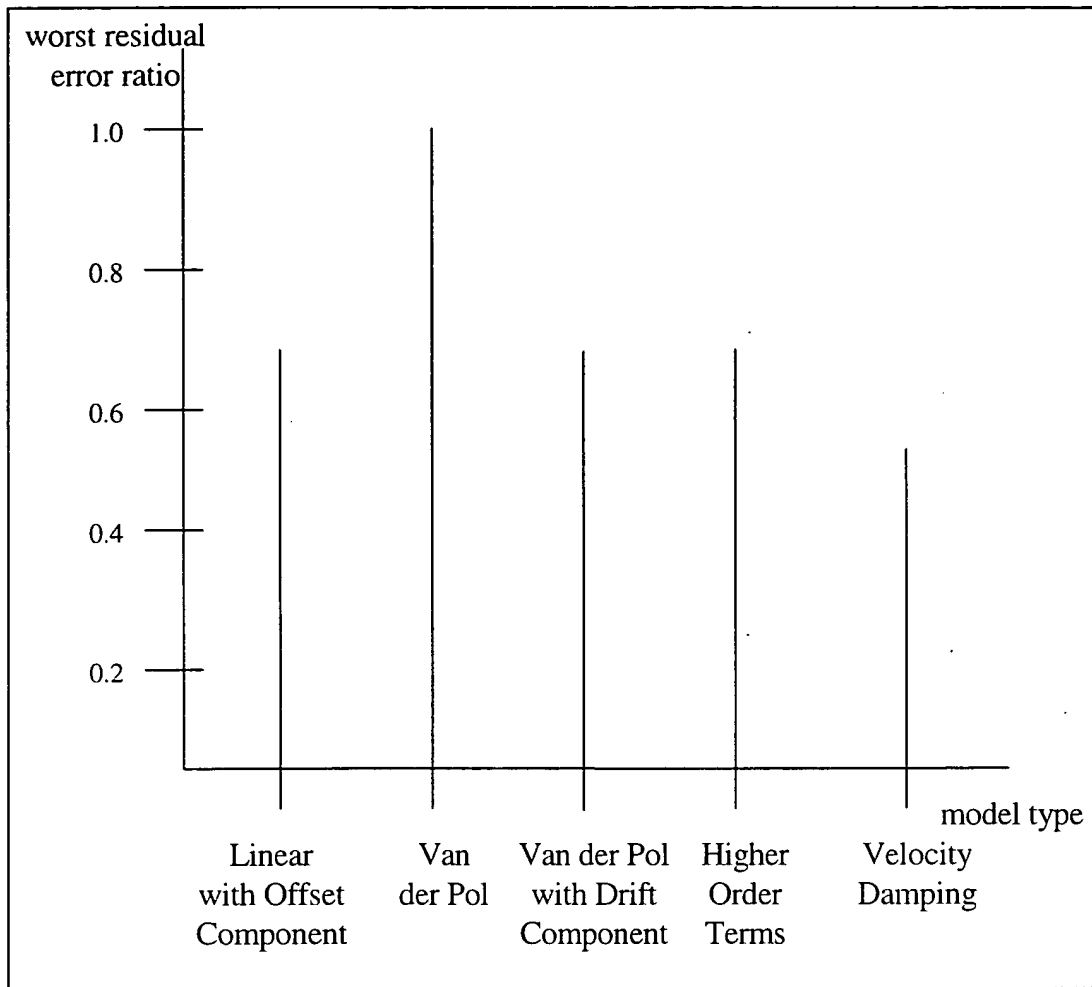


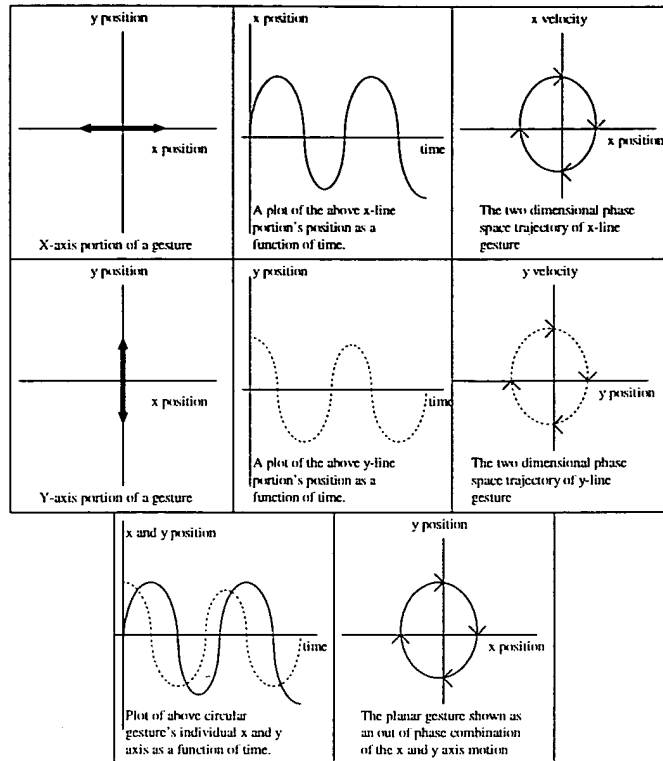
Figure 20: An Algorithm for Determining the Specific Gesture Model.



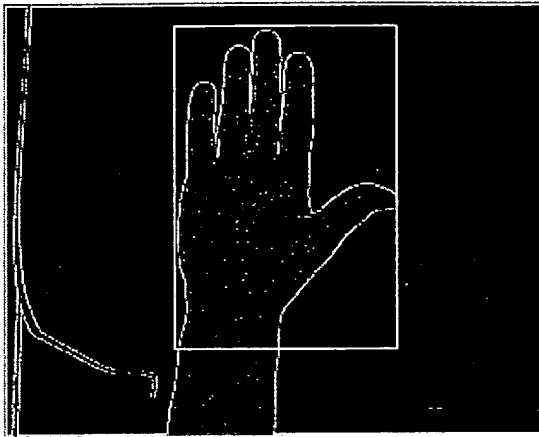
**Figure 21: An Exaggerated Representation of the Residual Error Measurement.**



**Figure 22: The Worst Case Residual Ratios for Each Gesture Model. The Lower the Ratio, the Better the Model.**



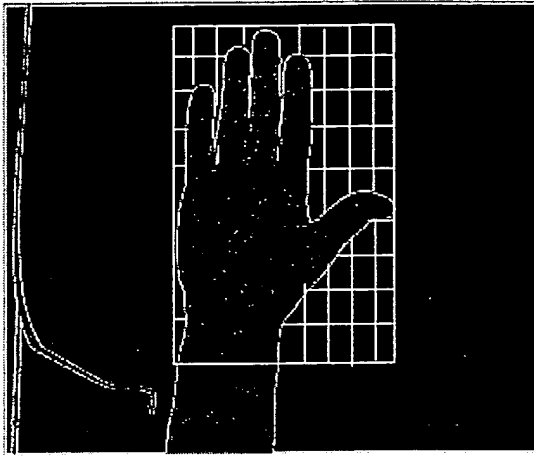
**Figure 23: Two Perpendicular Oscillatory Line Motions Combined into a Circular Gesture.**



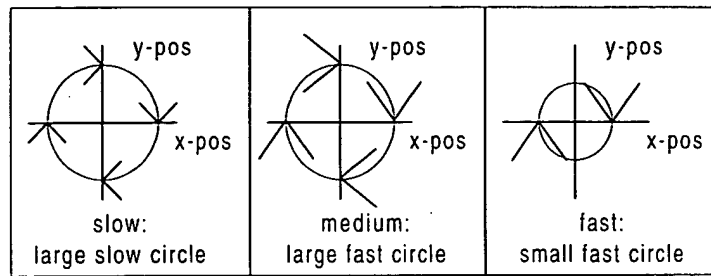
**Figure 24: Bounding Box Around Hand.**

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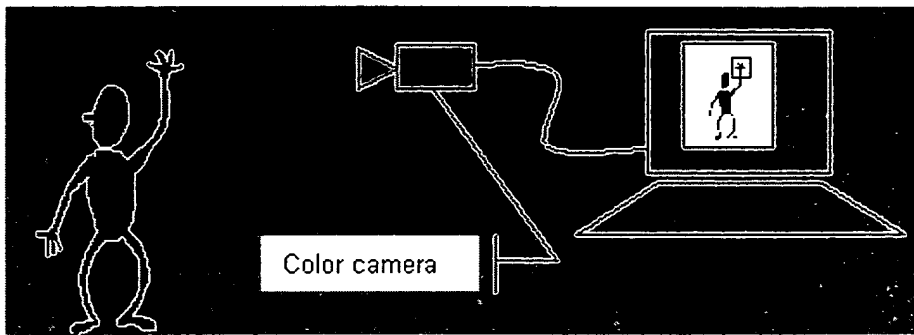




**Figure 25: Descriptions from Bounding Box.**



**Figure 26: The Example Gestures.**



**Figure 27: Schematic of the Hand Tracking System Hardware.**

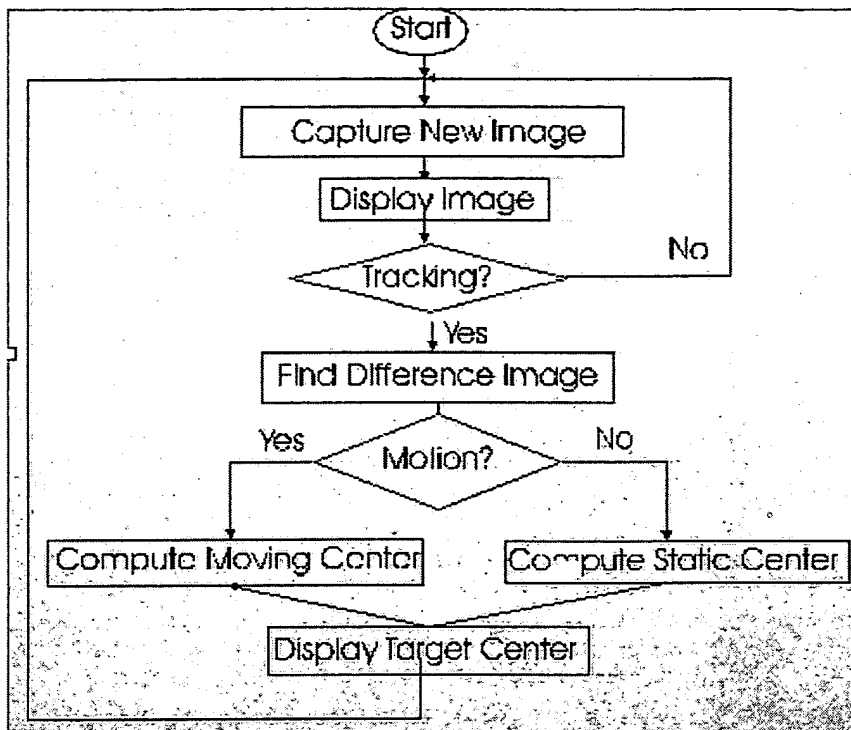


Figure 28: Flowchart of the CTS.

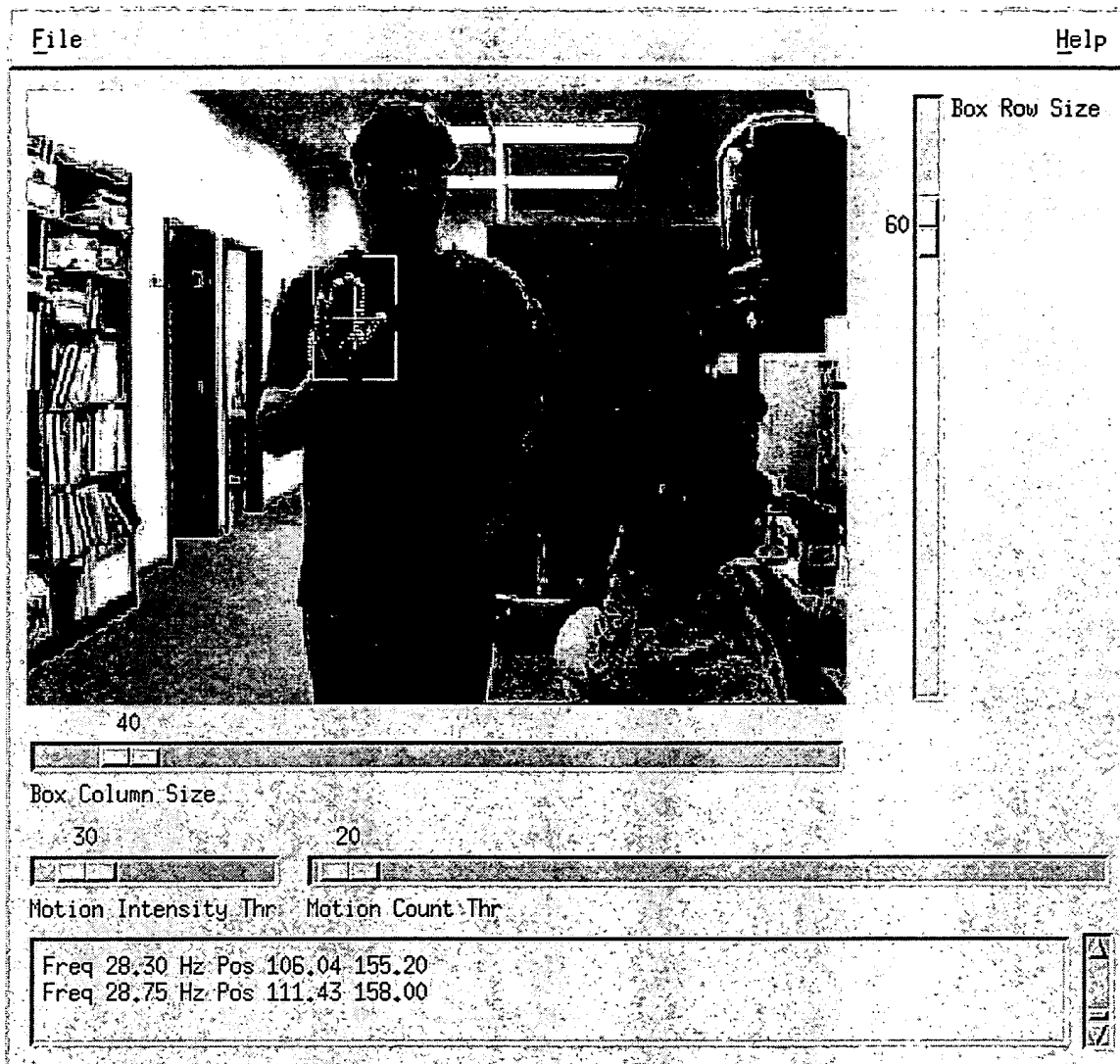
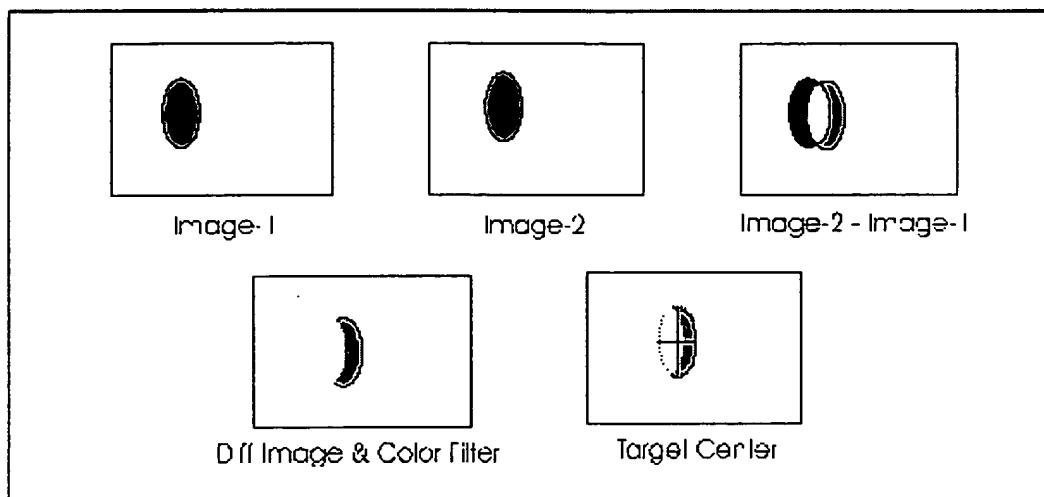
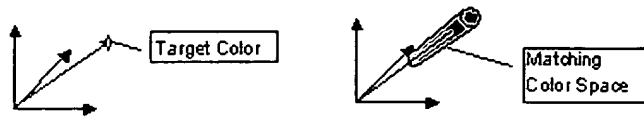


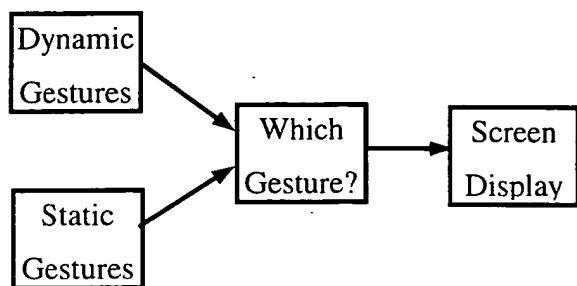
Figure 29: Graphical User Interface of the CTS.



**Figure 30: Target Center from Difference Image.**

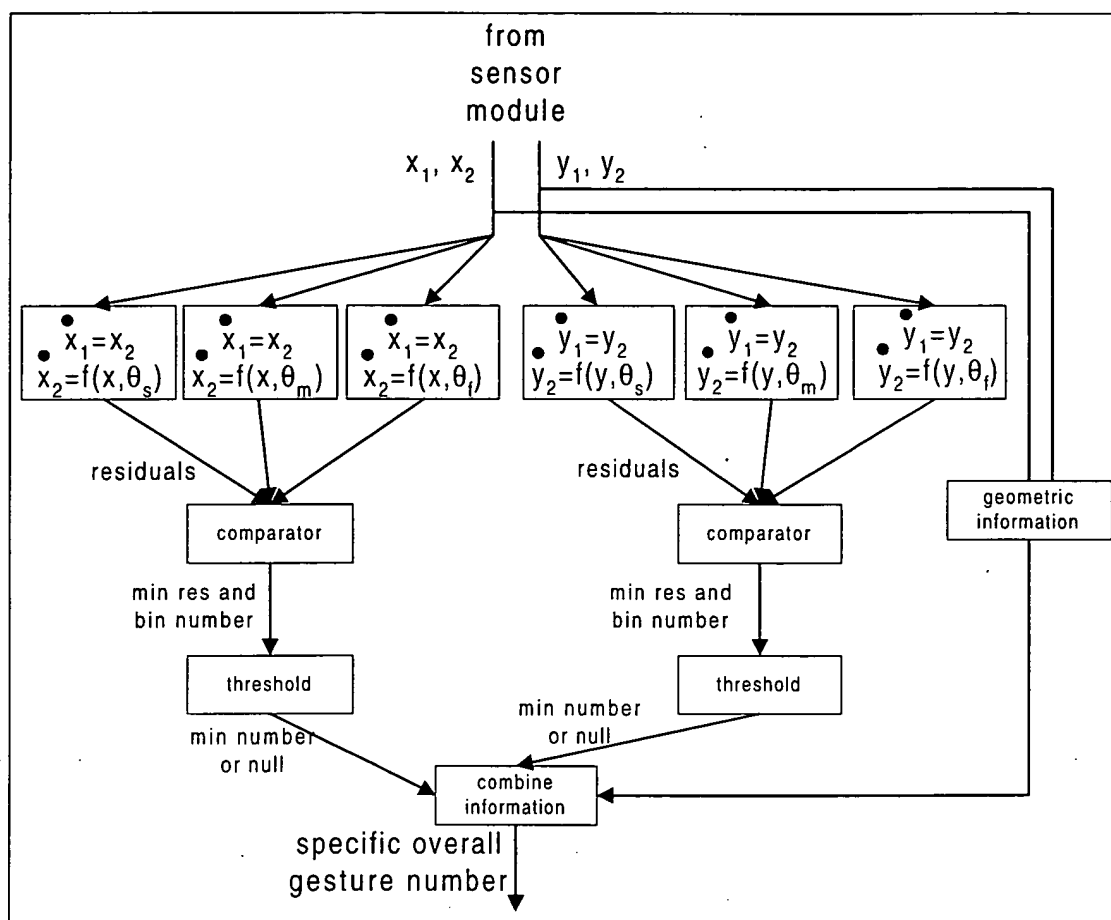


**Figure 31: Color Matching Technique.**

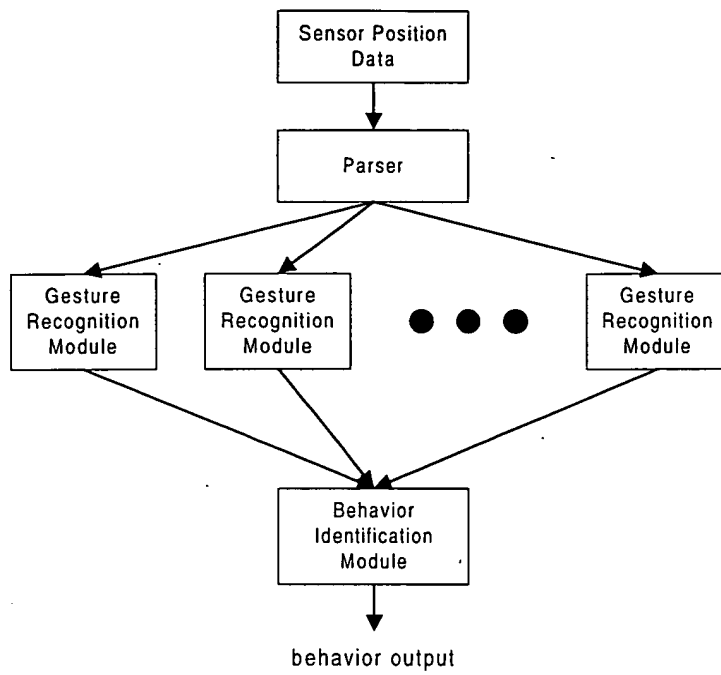


**Figure 32: Identification Module.**





**Figure 33: Simplified Diagram of the Dynamic Gesture Prediction Module.**



**Figure 34: Behavior Recognition Module.**